THE VETERINARY RECORD

FOUNDED BY WILLIAM HUNTING, F.R.C.V.S., 1888.

No. 31. JULY 29, 1944 VOL. 56.

The Effects of Various Intravenous Injections on the Horse*

STEPHEN J. ROBERTS, D.V.M., M.S.
ITHACA, NEW YORK

In the last 20 years, rapid progress has been made in intravenous medication of domestic animals. At the present time, this type of therapy is commonly and successfully used by every up-to-date veterinarian in the treatment of many diseases of horses and other animals. Most veterinarians are acquainted with the technique of intravenous medication and are aware of the advantages and disadvantages of this type of treatment through personal experience and from the numerous articles on this subject published in the veterinary periodicals of late years.

Most of the experimental work on the effects of the intravenous injection of drugs in both human and veterinary fields has been done on small experimental animals, such as cats and dogs. Knowledge thus obtained was then applied to treating human beings and larger domestic animals. This is understandable as the larger domestic animals, such as the horse, are relatively high in value and difficult to secure and maintain in large numbers for experimental purposes. Therefore, our knowledge of intravenous medication in horses, as to practical and satisfactory doses and actions of various drugs, is based mainly on experiments with small animals and with the actual experience of the practitioner treating horses in the field. But this leaves a wide gap in our knowledge of the specific effects on the horse's blood stream and body of many of the more common drugs given intravenously.

In endeavouring to lessen this breach, more than 200 experiments with 20 intravenous drugs and materials were made on 69 horses. The horses used in these experiments were obtained by the Kansas State veterinary school for use in operative surgical exercises. Most of the horses were aged or unable to work, due to some chronic, incurable condition, but the majority were quite strong and vigorous, making good experimental subjects.

METHODS

Before and after the intravenous injections, the physical reactions of the horses, including the pulse, respiration, temperature, and any unusual symptoms, were noted.

Special attention was given to the effects of the injections on the circulatory system, including an examination of the blood for haemoglobin values (Haden-Hauser method), haemolysis, red and white cell counts, specific gravity and total protein determinations (Kagan proteinometer), and an occasional blood calcium determination made by the Kramer-Tisdall method.

The influence of the various injections on the coagulability of blood was also noted. Since horse blood has normally a rather long coagulation time (11½ minutes, Dukes[1]), intravenous injections that would hasten the clotting time would be valuable in cases of accidental or surgical haemorrhage. It was recognised that there is no absolutely accurate clinical or laboratory check on the coagulation time since so many factors are involved. However, the capillary pipette method was adopted. After running a series of five coagulation times on each of six normal control horses, it was determined that the average greatest decline in coagulation time of the control horses was 37·3 per cent. This was based on the average coagulation time before the injection and the average greatest decline in coagulation time after the injection.

Urine examinations were made in some of the experiments, and these included: specific gravity determination by the urinometer; the reaction as determined by litmus paper; albumin determination by the Fish picro-aceto-glycerol test; sugar determination by the Benedict test; and the microscopic examination of the sediment from the centrifuged urine sample.

The intravenous solutions and fluids were injected into the jugular vein of the horses through a 12- or 14-gauge needle by means of gravity flow. The air or oxygen injections were made by gradually filling the gas-filled flask with water and forcing the gas into the vein through an intravenous needle.

AIR AND OXYGEN.—Numerous articles have mentioned the dangers of allowing even small amounts of air to gain entrance into the circulatory system, blaming the air emboli thus produced for sudden and unexplained deaths. According to Richardson, Cole and Hall[2] and Jones and Lockhart,[3] small amounts of air, oxygen, or carbon dioxide introduced into the venous circulation had no effect, as they were rapidly absorbed in the lung tissue with no evidence of cardiac or respiratory distress; no emboli were ever found in the arterial circulation. It was noted that air and oxygen were absorbed from the blood at about equal rates, with carbon dioxide being absorbed more rapidly than either. The injection of larger amounts of air was said to produce slight to severe cardiac and respiratory distress resulting in complete recovery or death, depending on the amount and rate of air injected intravenously.

Individuals with high blood pressure survived larger doses than did individuals with low blood pressure. The cause of death was either passive congestion of the right side of the heart and heart failure, or a lowering of the aortic pressure to zero, due to a lack of blood in the pulmonary veins and left side of the heart, causing cerebral anaemia and paralysis of the respiratory centre. These authors computed, after animal experimentation, that the approximate fatal intravenous dose of air for a 150-lb. man was 525 c.c. If injections were given very slowly, much larger doses might be given. According to Jones and Lockhart,[3] minute quantities of air injected into the left heart, or arterial circulation, produced severe reactions or death due to cerebral or coronary emboli. The fatal dose of air given intra-arterially for a 150-lb. man was determined to be 37·5 c.c.

Fifteen horses were given 24 injections of 500 to 4,000 c.c. of air or oxygen intravenously at rates varying from 150 to 500 c.c. per minute, and various results were noted. Small amounts of air or oxygen, such as might enter the venous circulation accidentally during intravenous medications, are harmless. Even injections up to 500 c.c. produced no or slight symptoms that soon disappeared with no harmful after-effects. Larger injections produced progressively more severe symptoms of cardiac distress, as shown by a marked increase in the rate and force of the heart beat; respiratory distress, as shown by dyspnoea, and nervous symptoms due to the drop in aortic pressure, as shown by restlessness, colicky symptoms, wobbling, incoordination, and falling. It was noted that there was a marked difference among horses in respect to their tolerance for these injections. Intravenous injections of oxygen did not give as severe reactions as did the same amount of air. Approximately 4,000 c.c. of air injected rapidly was necessary to cause the death of the average horse.

It was interesting to note that one cow was given an intravenous injection of 11,500 c.c. of air over a period of two hours before death resulted. One horse that was given an injection of 60 c.c. of air into the isolated right carotid artery developed marked nervous or cerebral symptoms, including ataxia, falling, dyspnoea, ptosis of the left eyelid, drooping of the left ear, and nystagmus. In about three hours, the horse had returned to normal.

TABLE I
COMPARISON OF NORMAL TESTS BEFORE INJECTION WITH RESULTS OF OTHER AUTHORS

Tests	Dukes'[1] Results	Malkmus'[33] Results	Experimental Results		
			Range	Average	No. of Horses
Coagulation time ..	11·5 min.	.....	7 to 78 min.	22·35 min.	56
Pulse rate	32 to 44 per min.	28 to 40 per min.	25 to 72	42	54
Respiration rate ..	8 to 16 per min.	8 to 16 per min.	10 to 68	20·9	54
Temperature	99 to 100·8° F.	99·5 to 101·3° F.	98 to 101·9° F.	99·58° F.	51
Red blood cell count ..	6,940,000 cells per c.mm.	7,500,000 cells per c.mm.	2,125,000 to 9,250,000	5,627,768 cells per c.	28
White blood cell count ..	10,000 cells per c.mm.	10,500 cells per c.mm.	3,600 to 17,600 per c.mm.	9,920 per c.mm.	28
Specific gravity of serum	.....	.....	1·0250 to 1·0333	1·02786	48
Total protein of serum ..	7·23 grammes per 100 c.c.	6·1*	6·00 to 8·37	6·99	48
Haemoglobin	12·4 grammes per 100 c.c.	.....	7·5 to 14	9·75 grammes per 100	43

*6·1 (Craige and Gadd[34]).

* Summary of thesis presented as partial requirement for the Master of Science degree at Kansas State College, 1942. Presented before the Section on Surgery and Obstetrics at the seventy-ninth annual meeting of the American Veterinary Medical Association, Chicago, Aug. 24th-27th, 1942.

Assistant professor, Department of Medicine, Obstetrics and Ambulatory Clinic, New York State Veterinary College, Ithaca, N.Y.

Reproduced from the *American Journal of Veterinary Research* (July, 1943). 4. 226-230.

Isotonic Saline Solution.—Physiological saline is frequently injected intravenously in horses for haemorrhage, heat stroke, toxaemia, and dehydration. According to Bastedo,[4] Sollmann,[5] and Milks,[6] the administering of physiological saline to normal animals produces a temporary rise in blood pressure and hydraemia. The blood volume and pressure returned to normal usually in about half an hour, as the blood regulatory mechanisms eliminated the excess volume either through the kidneys or into the tissues. Excessively large injections tended to produce pulmonary oedema and respiratory failure. Saline injected at reasonable rates and temperatures had no effect on the pulse or body temperature. However, other authors[7] have stated that hot and cold solutions may cause "vein block." According to Munson,[8] "speed shock," as seen in man, due to too rapid administration of the saline, does not occur in animals.

Numerous reports in human medical literature record the occasional occurrence of chills and a rise in temperature following intravenous saline medication. Seibert[9] showed this condition to be due to pyrogens or toxins from certain bacteria growing in saline solutions that lacked careful and frequent preparation.

Thirteen intravenous injections of 1,000 to 4,000 c.c. of physiological saline were given to nine horses at rates of 90 to 333 c.c. per minute, at temperatures that varied from 37·4° to 160° F. The following effects were observed: (1) Rapid injection rates resulted in no untoward symptoms except an increase in the rate and depth of respirations in some horses. (2) Injection of cold or hot saline had no observable effects on the horses, except that when very hot saline (160° F.) was injected, the horses became nervous and restless. (3) The body temperature of a horse given 4,000 c.c. of saline at 37° F. dropped 0·4° F., while the average body temperatures of the horses given 4,000 c.c. of saline at 110° to 160° F. rose 0·7° F.

The injection of 4,000 c.c. of physiological saline had a mild, temporary, hydraemic effect on the blood stream of six horses, as was shown by an average decline, five minutes after the injection, in the specific gravity, total protein value, red cell count, and haemoglobin value. The return to normal values was rapid. No chills nor marked temperature rises, such as occur occasionally in man, were seen in any of the horses in the experiments, although several of the saline injections had been allowed to "age" for several months.

Hypotonic Solutions.—Tap water and distilled water are common diluents for many intravenous drugs. The effects of unsterilised tap water and distilled water upon the blood stream of the horse had not been determined, and it was desirable to do this because many practitioners commonly use these unsterilised diluents in making their solutions just prior to intravenous injection. According to Dukes,[1] Bastedo,[4] and Sollmann,[5] hypotonic solutions injected intravenously cause a decrease in the osmotic pressure of the blood, tending to cause fluid to pass from the blood into the tissues. Mixture of hypotonic solutions with blood produces haemolysis in the horse when the sodium chloride or salt concentration of the blood becomes lower than 0·42 per cent. Following haemolysis, chills and fever may occur, with haemoglobin usually appearing in the urine. Immediate diuresis does not occur, as the tissues take up large quantities of water and renal circulation is slowed by the swelling of the kidney cells. Water excretion by other channels may produce diarrhoea. Physiological saline, tap water, and distilled water are progressively more toxic when injected intravenously in large doses.

Eight injections of tap water and eight injections of distilled water were given to 16 horses in amounts varying from 2,000 to 24,000 c.c., at rates of 190 to 285 c.c. per minute. After these injections, no significant changes in the pulse rate, respiration rate, or body temperature were observed, and only mild physical reactions of nervousness and deep respirations developed in a few horses. Four horses developed a profuse, watery diarrhoea after the injections. Another horse developed an attack of singultus or hiccoughs that lasted for 15 minutes. One horse, given 12,000 c.c. of distilled water, died suddenly during the injection, and *post-mortem* examination revealed a passive congestion of the lungs and oedema around the base of the heart.

Lysis of red blood cells, with haemoglobin in the urine, appeared in all horses given more than 4,000 c.c. of a hypotonic solution. No haemolysis was noted in any horse given less than 2,000 c.c. of distilled water or tap water. This haemoglobin, or red colour in the urine, lasted in most cases for about 24 hours, with no observable temporary or permanent injury to the horse. As with the isotonic saline injections, there was a brief period following the injections when a hydraemia was apparent. No immediate diuresis occurred in any of the horses. Even though the distilled water and tap water were not sterilised, no unusual symptoms, such as chill or fever, were noted after the injection, nor did any observable symptoms of infection or septicaemia develop in horses that were kept weeks or months after the injection.

It was interesting to note that two horses were given 20,000 and 24,000 c.c. of tap water, respectively, in approximately one and a half hours, with no marked clinical symptoms other than a haemoglobinuria that persisted for 12 to 24 hours. Large injections of distilled water produced more pronounced reactions than did like amounts of tap water, probably due to the fact that the tap water contained some mineral salts in solution. Even though these experiments indicate that large amounts of unsterilised tap water or distilled water may be given intravenously to the horse, good practice dictates that solutions should be sterile and injections of hypotonic solutions of more than 1,000 c.c. should be avoided.

Hypertonic Sodium Chloride Solution.—According to Milks,[6] Sollmann,[5] and Bastedo,[4] injections of large amounts of hypertonic solutions caused a rapid increase in the osmotic pressure of the blood, and thus in blood volume, due to the absorption of fluid from the tissues which produced a definite hydraemic condition that lasted a relatively short time. Hypertonic solutions were more strongly diuretic than isotonic solutions, and so might possibly be of use in combating toxaemia. Large amounts of hypertonic solutions injected intravenously caused severe stimulation of the central nervous system, due to the withdrawal of fluid from those structures. Bastedo[4] and Jones and Hewitt[10] state that intravenous injections of a 30 per cent. solution of sodium chloride caused an active peristalsis in normal, as well as paretic, intestines and the amount of the solution, rather than the concentration, appeared to be the significant factor. The sodium ion was said to be responsible for the stimulation of the intestinal musculature. Large amounts of hypertonic sodium chloride solution injected intravenously were relatively non-toxic to the circulatory and respiratory systems of dogs.

Ten intravenous injections of 30 to 120 grammes of sodium chloride in 15 to 30 per cent. solutions were given to nine horses. No significant changes were noted in the pulse or respiration rates, body temperature, haemoglobin value, or red and white cell counts. No haemolysis occurred, but a decline in the specific gravity and total protein values resulted after the injections, due to the hydraemic condition. No unusual clinical symptoms were noted in any of the horses, except that a few became restless during the injection, and one horse developed a pronounced sweating from the entire body surface that lasted for about six hours. In all of the cases, a definite increase in peristalsis occurred, with several horses defaecating at frequent intervals after the injections. Also, there was noted a definite decline in the coagulation time of 57 per cent., as based on the average coagulation times before the injections and the average greatest drop in coagulation time after the injections. This period of lowered coagulation time lasted two to four hours before returning to normal.

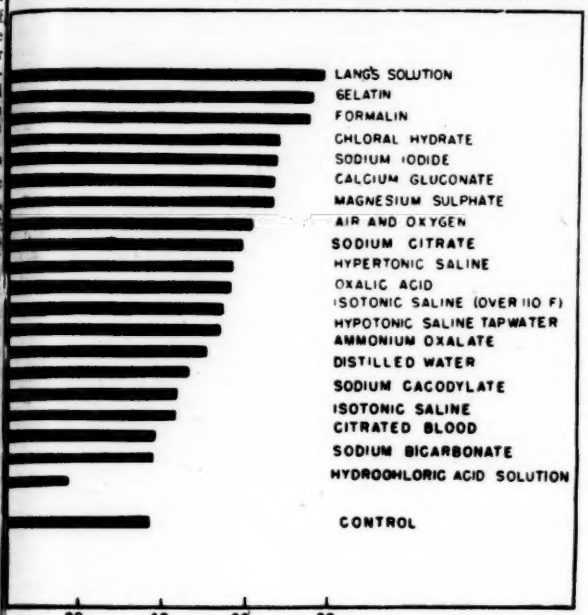
Sodium Citrate.—Sodium citrate has long been used as an anticoagulant in indirect blood transfusions. It has been combined with sodium chloride to make Lang's solution. Bastedo[4] and Druillet[11] advocate sodium citrate as an intravenous agent that will hasten the coagulation of blood *in vivo*. The dose advised by Druillet for horses is 20 to 25 grammes in a 30 per cent. solution. According to Sollmann,[5] sodium citrate in small doses, when injected slowly, causes slight physical symptoms. Larger doses, given rapidly, often produce symptoms of calcium deprivation, including cerebral excitation, muscle twitchings, tetany, and finally respiratory and circulatory collapse.

Eleven intravenous injections of 1 to 3 oz. (30 to 90 grammes) of sodium citrate in 15 to 30 per cent. solutions were given to ten horses at rates of from 50 to 150 c.c. per minute. No significant changes occurred in the body temperature, specific gravity, total protein values, haemoglobin values, or red and white cell counts. No haemolysis was present. A definite to a marked increase in the calcium level of the blood serum occurred five minutes after the injection of sodium citrate. This increase was probably due to the mobilisation of the calcium ions from the tissues into the blood to restore the calcium ions removed, but probably still present, in a non-ionised combination with the sodium citrate. The calcium evel returned to normal within 30 minutes after the injection.

The coagulation time was reduced 59·2 per cent., as computed by the average coagulation time before the injection and the average greatest decline in coagulation time after the injection. This drop in coagulation time lasted about two hours and gradually rose to normal in 24 hours. Marked physical symptoms of acute calcium deprivation were shown by the horses given 2 and 3 oz. of sodium citrate. These symptoms included increased pulse and respiratory rate, restlessness, inco-ordination, prostration, and symptoms of tetany with extension of the limbs, head and neck. In some cases, salivation and sweating were observed. These horses regained their feet in five to ten minutes and were normal in 30 minutes. To prevent these reactions, the larger doses of sodium citrate had to be given very slowly.

Lang's Intravenous Solution.—Lang's intravenous solution, consisting of 2 oz. each of sodium chloride and sodium citrate in 1,000 c.c. of distilled water, was proposed by W. W. Lang,[12] of England, in 1936, as a successful treatment for caecal impaction in

Graph I—The Relative Effects of the Various Intravenous Solutions on the Coagulation Time of Horse Blood



the horse. The treatment according to Lang, resulted in the drinking of large quantities of water, stimulation of peristalsis, and improvement in the appetite and attitude, with the elimination of a large amount of faeces within 24 hours. In this country, a weaker solution of 1 oz. each of sodium chloride and sodium citrate in 500 c.c. of distilled water has been used with variable success. According to Lang[12] and Rose,[13] this solution should be injected slowly, and heart stimulants should be given to weak patients. Jones and Hewitt[10] and Lang[12] describe an increased intestinal tonus and motility after intravenous injection of this solution, although the former state that this solution was slightly toxic to anaesthetised dogs.

Seven intravenous injections of Lang's solution were given to six horses at rates of 25 to 200 c.c. per minute. Two of the injections were of the original Lang's solution and five were of the modified solution (1 oz. each of sodium chloride and sodium citrate in 500 c.c. of water). No significant changes occurred in the haemoglobin values, respiration rate, body temperature, specific gravity, total protein values, or red and white cell counts. No haemolysis was noted. Slight clinical symptoms were noted with the modified solution. An increase in the pulse rate occurred and was most marked in the original, larger injections. Slight thirst, restlessness, and a definite increase in peristalsis and defaecation occurred. However, in the larger solution (containing 2 oz. each of sodium citrate and sodium chloride), symptoms of calcium deprivation occurred unless the material was injected slowly. These symptoms closely resembled those produced by large injections of sodium citrate, but were not so marked.

Intravenous injection of Lang's solution caused a marked drop in coagulation time of 78·3 per cent.; this was more marked than for either the sodium chloride or sodium citrate injections alone. This decline lasted for three to four hours before the coagulation time gradually rose to normal.

Sodium Iodide.—Sodium iodide is a drug used intravenously in horses for treating fistula of the withers and other suppurative conditions. The ordinary dose is 1 oz. (30 grammes) in 250 to 500 c.c. of water. According to Sollmann,[5] the immediate toxicity of sodium iodide given intravenously is low, although continuous use may lead to chronic iodism.

Ten intravenous injections of 1 oz. (30 grammes) of sodium iodide in 30 to 500 c.c. of distilled water, 100 per cent. to 6 per cent. solutions, were given to nine horses. No physical symptoms were observed. No significant changes occurred in the pulse rate, respiration rate, body temperature, specific gravity, or total protein values. After the injection, a slight decrease in the haemoglobin values and red and white cell counts was observed. A definite decline in the coagulation time of 67·4 per cent. resulted. This decline, also, was based on the average coagulation time before the injections and the greatest drop in coagulation time after the injection. This lowered clotting time lasted for approximately two hours.

Sodium Bicarbonate.—Sodium bicarbonate is probably one of the most useful drugs, but its intravenous use in man and animals has been rather limited as it is so readily absorbed from the digestive tract. Bastedo[4] states that intravenous injections of sodium bicarbonate stimulated diuresis with alkaline urine, increased the alkalinity of the body, and caused an increase in the lymphocytes. Excessive doses produced alkalosis and oedema. Jones and Hewitt[10] state that sodium bicarbonate given intravenously to the dog caused a marked stimulation of intestinal tonus and motility. Sodium bicarbonate has been used in domestic animals to combat acidosis present in such diseases as azoturia, ketosis, acetonaemia, and bronchopneumonia, but its success has been variable. However, Hixon[14] reports a marked reduction in deaths in cattle suffering from the shipping fever diseases following intravenous injections of an 8 per cent. sodium bicarbonate solution.

Two injections of 2,000 c.c. and one injection of 4,000 c.c. of an 8 per cent. sodium bicarbonate solution were given intravenously to three horses. No significant clinical or blood changes were noted after these injections except that one horse developed a definite diuresis one to two hours after the injection, with the specific gravity of the urine dropping from 1029, before the injection, to 1012 after the injection.

Sodium Cacodylate.—Sodium cacodylate was one of the earliest organic arsenic compounds used in medicine. It has been used with questionable success in horses for the treatment of influenza, pneumonia, chronic skin diseases, and anaemia. According to Milks[6] and Sollmann,[5] sodium cacodylate has only a feeble, rather non-toxic reaction in the body since it releases its arsenic ions slowly. In later years, it has yielded to the more efficient and rapid acting arsenical compounds. It is eliminated mainly unchanged in the urine and also in the sweat and breath, giving them a garlic-like odour. Excessive doses produced typical arsenic poisoning. Sollmann[5] states that, given intravenously in man, it usually produced a fibrosis of the vein.

Eight intravenous injections of 10 grammes (150 grains) of sodium cacodylate in 50 to 150 c.c. of distilled water were given to five horses. Little, if any, effect on the circulatory system or body of the horse was noted. One horse developed a marked phlebitis from the intravenous injection. Another horse, given four daily injections of 150 grains of sodium cacodylate, had a marked drop of 42 per cent. in the red cell count.

Oxalic Acid.—Oxalic acid, which previously had been of no use in therapeutics, has been described by Steinberg and Brown,[15] Miller and Davies,[16] and Stapleton[17] as an agent which, when injected intravenously, would produce a marked lowering of the coagulation time. According to Sollmann[5] and Bastedo,[4] oxalic acid and the oxalates have an acid action in the body causing symptoms of poisoning, brought about by the precipitation of calcium from the tissues. Intravenously, large doses of oxalic acid caused central nervous stimulation, nervousness, tetany, convulsions, and finally paralysis, death being due to a respiratory paralysis except after excessively large doses when the heart muscle may become paralysed. Oxalic acid is eliminated by the urine as calcium oxalate; this compound may, and often does, precipitate in the tubules of the kidney producing a nephritis. Steinberg and Brown,[15] and Stapleton,[17] advise the use of 1 to 3 mg. of oxalic acid for human beings and small animals; Stapleton,[17] and Miller and Davies,[16] advise the use of 100 to 200 c.c. of a 5 per cent. oxalic acid solution for horses, to cause a lowering of the coagulation time of the blood. Foster[18] reports that in his work with oxalic acid, it had no lowering effect on the coagulation time.

Ten injections of 100 to 200 c.c. of a 5 per cent. oxalic acid solution were given intravenously to nine horses. Slight physical reactions, including restlessness, excitement, salivation, defaecation, and increased pulse and respiration rates, occurred in the horses given 100 c.c. of a 5 per cent. oxalic acid solution. The larger injections of 200 c.c. produced more severe reactions of sweating, excitement, quivering, colicky pains, staggering and collapse, marked rise in pulse and respiration rates, and increased peristalsis and defaecation. One weak, emaciated horse died suddenly with symptoms of heart failure two to five minutes after the injection of 200 c.c. of 5 per cent. oxalic acid. In several cases, a moderate phlebitis developed in the jugular vein following the injection. In some, symptoms of a mild nephritis appeared with oxalates, albumin, and lowered specific gravity of the urine following the injection. In several cases, there developed a brief rise in the red and white blood cell counts. There was an average decline of 56·6 per cent. in the coagulation time that lasted for several hours after the injection of the oxalic acid.

Magnesium Sulphate.—Magnesium sulphate solutions have been used intravenously as a sedative and narcotic, especially in tetanus. Lately, magnesium sulphate has been combined with chloral hydrate as a general sedative and narcotic. According to Milks,[6] the use of magnesium sulphate solutions for nerve blocking and general anaes-

thesia was discovered in 1905 by Meltzer and Auer. Magnesium salts have a paralysing action on the motor nerve and plates in the muscle, and also a marked depressant action on the central nervous system. However, Sollmann[5] states that complete surgical anaesthesia was difficult to obtain, as this state is produced only by the near toxic dose of magnesium sulphate. According to Milks,[6] moderate doses have a diuretic effect.

Five injections of 500 c.c. of 10 and 20 per cent. magnesium sulphate solutions were given to four horses. No significant changes were noted in the haemoglobin values, red and white blood cell counts, specific gravity, or total protein values. No haemolysis occurred. The pulse rate increased after the injection of the 10 per cent. solutions, and increased markedly after the injections of the 20 per cent. magnesium sulphate solutions. The respiration rate was deeper and slower after the 20 per cent. than after the 10 per cent. injections. Only a slight depressant action on the horses resulted from the administration of 500 c.c. of a 10 per cent. solution, while after 500 c.c. of the 20 per cent. solution, the horses staggered and fell, rested quietly, and regained their feet in 20 to 30 minutes, but remained lethargic for several hours. In several horses, surgical anaesthesia was attempted by the use of the 20 per cent. solution, but respiratory paralysis and death occurred before anaesthesia was obtained; one horse received 1,300 c.c. of a 20 per cent. magnesium sulphate solution during an hour and a half before death resulted. Hypertonic magnesium sulphate solutions given intravenously caused a definite lowering of the coagulation time of 66·3 per cent. This decline lasted for several hours before the coagulation time returned to normal.

Chloral Hydrate.—Chloral hydrate is a common drug used orally and intravenously to produce narcosis or anaesthesia in the horse. Moderate doses of chloral, according to Alstead,[19] Bastedo,[4] Sollmann,[5] and Milks,[6] are safe, producing a depression of the cerebrum without appreciably affecting the respiratory or circulatory systems. However, a profound narcosis, not produced by moderate doses, must be reached before pain is abolished. The larger doses of chloral hydrate depressed the heart muscle and all of the motor centres, including the cardiac, respiratory, and vasomotor. Peripheral arterial dilation, due to depression of the vasomotor centre, together with decreased movements and depression of the heat-producing centre, caused chloral to be markedly antipyretic. Krill[20] and Ingmand[21] state that chloral is contra-indicated in old, debilitated horses. Bastedo[4] states that this drug is also contra-indicated in man suffering from threatened failure of the circulatory system and depressed states of respiration, such as pneumonia. Sollmann[5] mentions that, in cats, a sudden stoppage of the heart may occur from relatively small doses of chloral hydrate, under the influence of excitement.

Krill[20] and Ingmand[21] state the common intravenous dose of chloral for the horse to be 1 to 2 oz. in a 6 to 10 per cent. solution, given slowly. However, Fowler[22] says that the average horse could be given 2 oz. orally, followed by 2 to 4 oz. intravenously. Milks[6] states that the fatal dose for the horse varies between 5 and 8 oz., with death due to paralysis of respiratory centre, or by direct depression of the heart muscle, and heart failure.

Eleven horses were given twelve intravenous injections of ½ to 3 oz. of chloral hydrate in 100 to 1,000 c.c. of distilled water in 6 to 24 per cent. solutions. Slight haemolysis occurred in two horses given 2 and 3 oz. of chloral, respectively. The coagulation time dropped 68 per cent. after the injection and the decline lasted for nearly eight hours before rising to normal in 24 to 48 hours. No other significant change in the blood occurred. Following the injections of chloral hydrate, the pulse accelerated, but the respirations were definitely slowed. The larger the dose of chloral, the more pronounced the narcosis that developed and the greater the reduction in body temperature. Two animals given 2 oz. of chloral intravenously went down and remained quiet for one-half to one hour and, in struggling to rise, died within several minutes, apparently from heart failure. One of these animals was a strong, but aged, mule and the other was a strong, five-year-old horse. These sudden deaths have also been seen occasionally in surgical patients presented at the clinic. Possibly these deaths may be explained by an idiosyncrasy of some horses toward chloral, or by struggling, or exertion while under the influence of the narcotic. Several horses given 3 oz. of chloral defaecated frequently 30 minutes after the injection. One pony given 1 oz. of chloral in 250 c.c. of water developed a marked phlebitis, with distension of the jugular vein.

Calcium Gluconate.—Calcium gluconate is one of the more common drugs given intravenously in veterinary medicine. It is usually prepared in a 20 per cent. solution with 4 per cent. boric acid. According to Dukes,[1] Sollmann,[5] and Milks,[6] calcium decreases the irritability of nerves and the permeability of cells and capillaries. Slight decreases in the blood and tissue calcium caused an increase in the irritability and a slight decrease in the strength of all neuromuscular tissues, possibly leading to spontaneous fibrillary twitchings, jerking of muscles, and convulsions. An increase in the calcium of the blood and tissues lessened the irritability of neuromuscular tissues, but increased the strength of contraction. Following the injection of moderate amounts of calcium gluconate, the heart rate slowed at first, and then increased, with a rise in blood pressure. The hypercalcaemia thus produced lasted for several hours. Large intravenous doses of calcium produced toxic symptoms of cardiac weakness, tachycardia, fall in blood pressure, paralysis of respiration and death due to ventricular fibrillations. Krill[20] and Bastedo[4] state that calcium gluconate should be injected slowly, especially in patients affected with heart weakness or a lowered blood pressure, as rapid administration brings on toxic symptoms from doses which, when given slowly, are harmless.

Calcium gluconate in large doses produced a diuretic effect, according to Bastedo[4] and Sollmann[5]; however, in excessively large doses anuria resulted. Calcium gluconate under certain conditions caused a lowering of the coagulation time. Jones and Hewitt[10] and Bastedo state that calcium gluconate increased the tone and peristalsis of the intestines.

Eleven intravenous injections of 250 to 3,000 c.c. of 20 per cent. calcium gluconate were given to ten horses at rates of 62·5 to 150 c.c. per minute. The smaller injections of 250 to 500 c.c. produced no observable reactions and only slight changes in the blood. The larger injections of 1,000 to 3,000 c.c. produced mild to marked physical reactions, consisting of trembling, restlessness, yellow nasal discharge, lachrymation, slight colicky pains, and, in some, tenesmus. Most of the horses given the larger injections developed a definite diuresis and an increased frequency of defaecation. One horse, given 3,000 c.c. of calcium gluconate, developed these symptoms, except that anuria instead of diuresis occurred. The blood calcium of this horse rose from 11·2 mg. per 100 c.c. of serum before the injection to 33 mg. five minutes after the injection and had dropped to 29·7 mg. in one hour. An increase in the pulse and respiration rates occurred, with a more marked increase after the larger injections. The urine of one horse developing a diuresis became acid in reaction, clear in colour, low in specific gravity, and positive to Benedict's sugar test due to the gluconic acid present.

A drop in coagulation time occurred in all of the horses, but declined most markedly in the horses given the larger injections of 500 to 3,000 c.c., with an average drop of 66·9 per cent. This decline in coagulation time lasted approximately two to three hours and rose gradually to normal within 24 hours.

Formalin Solutions.—Formalin solutions have been used intravenously in horses for treating purpura haemorrhagica. Formalin, because it combines with a large number of organic substances and coagulates protein, is irritating to body tissues. Sollmann[5] states that, because of this characteristic, it is seldom used in the body. The fatal dose of formaldehyde for mammals is 0·08 to 0·09 gramme per kg. of body weight. Thus, the fatal dose of formaldehyde for the average 1,000-lb. horse would be 38·2 c.c. or 95·5 c.c. of formalin. Udall[23] and other practitioners state that the average dose of formalin, intravenously, varies from 4 to 16 c.c., given in 10 to 25 per cent. solutions and repeated as indicated, in treating purpura. Certain practitioners, in treating flatulent colic, advise similar intravenous doses of formalin.

Twenty-two intravenous injections of 4 to 12 per cent. formalin solutions were given to 19 horses. The amount of formalin varied from 4 to 50 c.c. given in 40 to 500 c.c. of distilled water. The physical reactions of the horses to these injections varied with the amount of formalin injected, the rate of injection, and the concentration of the formalin solution. The smaller amounts of formalin, 4 to 8 c.c., caused slight reactions, including restlessness, lachrymation, elevation of the tail, slight salivation, and occasional defaecation. The larger, more concentrated solutions and faster rates of injection produced definite to marked reactions, including lachrymation, salivation, nasal discharge, increased peristalsis with frequent defaecation, sweating, slight quivering to spasms of muscles, severe abdominal pain, and distress with tenesmus. These symptoms corresponded closely with those described by Andberg, Boyd, and Code[24] for histamine and foreign protein shock produced by them in horses, with the exception that in foreign protein shock, the coagulation time of blood is prolonged, while the coagulation time after the formalin injections was shortened.

The pulse was generally accelerated after all of the injections, and the respirations only slightly increased, with deeper abdominal breathing. The body temperature showed a slight, but definite, rise. In a number of cases, the red cell count showed a definite rise. There was a very definite average drop in the coagulation time of 75·2 per cent. It was noted that the amount of formalin in the injections, rather than the concentration of the solution, had the greater effect on coagulation time. The larger amounts of formalin, over 16 c.c., caused an average drop in coagulation time of 86·3 per cent., while the 8 to 16 c.c. amounts caused an average decline of 67·3 per cent. Since the larger injections caused more severe physical reactions

the 8 to 16 c.c. amounts of formalin in solution were preferred. This lowered coagulation time lasted approximately 24 hours.

During these experiments, solutions of 10 c.c. of formalin in 100 c.c. of water were used to control haemorrhage in two clinical cases. One pure-bred, seven-year-old saddle mare, affected with a chronic catarrh of the guttural pouches, developed a profuse nasal haemorrhage during the irrigation of the pouches. The other, an eight-year-old draft mare, developed severe haemorrhage following the removal of an exuberant mass of granulation tissue too high on the forearm to bandage. In both cases, the haemorrhage decreased and finally stopped five to ten minutes after the injection.

Gelatin.—Gelatin has been recommended as a product for intravenous injection, in dilute solutions, for the treatment of shock and to reduce the clotting time of the blood. According to Milks,[6] 2 per cent. solutions given intravenously increased the coagulability of blood; the reason for this effect is not known. Because of this effect, gelatin has been used for the treatment of haemorrhage, shock, and purpura haemorrhagica in horses. Gelatin is not a complete protein, so there is no danger of producing anaphylactic shock by repeated intravenous injections. Because of the slight possibility of unsterilised gelatin solutions containing tetanus spores, gelatin solutions should be sterilised at 15 lb. pressure for 20 minutes. Recently, human investigators[25 26] have stated that gelatin, taken orally, caused a reduction in the rate of muscular fatigue, and a marked increase in work output of persons given a diet containing gelatin. Possibly, but unlikely, therefore, the intravenous injection of gelatin in the racehorse prior to a race might increase the work output and reduce fatigue, as well as increase the coagulability of blood and thus prevent nasal haemorrhage in "bleeders," or horses that have a tendency toward nasal bleeding during severe exertion.

Ten injections of 250 to 500 c.c. of 2 to 6 per cent. gelatin solution were given intravenously to seven horses. They were given at the average temperature of 105° F. No clinical reactions or symptoms were noted after any of the injections. No haemolysis occurred, and the pulse rate, respiration rate, body temperature, red and white blood cell counts, specific gravity, and total protein values were unchanged. The coagulation time was definitely reduced, the average decline being 76 per cent. This figure was based on the average time before the injection and the greatest decline after the injection. The greatest decline occurred 32 minutes after the injection and lasted for nearly eight hours before rising to normal. Two horses given two and three injections respectively, of unsterilised gelatin solutions three weeks to four months apart showed no symptoms of anaphylaxis or tetanus.

Blood Transfusions.—Blood transfusion has been the subject of much study and experimentation during the last 20 years, and new methods and reports of results of transfusions in horses have been reported in numerous articles. Two methods of transfusion, indirect and direct, are used in horses. According to Lyon,[27] for all practical purposes, horse blood may be transfused into any other horse without danger of agglutination or shock. However, Amadon[28] and Koch [29] reported that, in rare cases, the blood of one horse may be incompatible with that of another and produce symptoms of shock, including trembling, sweating, and muscular weakness. Most workers advise injecting blood at nearly body temperature. However, Krill[20] and others[30] stated that there was less likelihood of producing shock in horses with chilled blood or serum. Injections should be given slowly, with a close watch for any reaction that might develop. Many serums are pasteurised at 58° C. or 136·4° F., and if the pasteurising temperature exceeds this temperature, shock frequently occurs. Milks[6] and Bastedo[4] state that, in haemorrhage, blood is frequently transfused to aid clotting by increasing the coagulability of the recipient's blood.

Since so much work had been done previously with transfusion in horses, only five injections of 500 c.c. of citrated blood were given to five horses, at rates of 63 to 125 c.c. per minute, at extremes of temperature from 32° to 150° F. No unusual clinical symptoms developed after any of the injections, except that one horse, injected with 200 c.c. of overheated blood, developed symptoms of shock, including dyspnoea, sweating, distress, and defaecation. No changes occurred in the blood stream and no significant lowering of the coagulation time resulted in any of the transfusions.

Hydrochloric Acid Solution.—The intravenous injection of dilute hydrochloric acid solution was advanced several years ago as a treatment for human infections. It has since been used in doses of 200 to 500 c.c. of a 1 : 1,000 to a 1 : 3,000 concentration in veterinary medicine for such infectious conditions in horses and cattle as mastitis, keratitis, metritis, fistula, and puncture wounds. It is highly recommended by Hixon[31] as a treatment for the latter condition. Little controlled experimental work has been done on this type of therapy.[32] The actual mode of action in the body is not known. Sollmann[5] and Bastedo[4] state that this therapy caused a flocculation of the plasma proteins with colloidoclastic reactions, including stimulation of leucocytosis, thus increasing the body resistance against infection. Due to the acidity and haemolytic nature of the dilute hydrochloric acid solution, an haemolysis and alteration of blood colloids occurred that produced a foreign protein-like reaction. Others[31] state that this caused a shifting of the alkaline-acid balance of the blood, with an increase in phagocytosis.

In a series of 23 intravenous injections of dilute hydrochloric acid solution in concentrations of 1 : 100 to 1 : 2,500, 500 to 4,000 c.c. were given to eleven horses. No clinical reactions to the injections were noted. No haemolysis nor change in the total protein or specific gravity was observed. No significant changes resulted in the haemoglobin values, coagulation time, or red cell count. No increase in leucocytosis occurred in any, except three horses that were affected, respectively, with a cellulitis of the hind limbs, fistula of the withers, and a periphlebitis due to the escape of hydrochloric acid solution outside of the vein.

Miscellaneous Observations.—During the injection of practically any material, the horses often became slightly restless and champed their jaws. Repeated daily injections of nearly any solution over a period of time tend[d] to decrease the haemoglobin value, specific gravity and total p[rotein] in value, and red cell count, and to increase the coagulation time. It was noted that, in many horses given near maximal intravenous doses of drugs that produced a severe physical reaction, there was a marked slowing of the sedimentation rate of the red blood cells. In giving large or near maximal doses of intravenous medication to old, thin, or debilitated horses, extreme care should be used. The injections should be given slowly, and the pulse, respiration, and physical reactions should be closely observed.

Since horse blood has normally a long coagulation time, it is often desirable to check haemorrhage. Intravenous agents such as gelatin, calcium gluconate, sodium citrate, oxalic acid, and blood have been used as drugs that hasten the coagulation time of blood in horses. From Graph 1, it may be noted that other drugs are even more effective than those that have previously been used as intravenous agents in horses.

In the experiments with 63 horses and mules of all sizes, ages, and conditions, the normal coagulation times, pulse rates, respiration rates, body temperatures, specific gravity and total protein values, red cell counts, white cell counts, and haemoglobin values were noted, if possible, and the results were compared with those of other authors (Table I). However, it should be kept in mind, when observing the table, that 91 per cent. of these horses and mules were over twelve years of age, most of them were fairly thin, and a few of them were suffering from various chronic ailments.

Conclusions

These conclusions were based on over 200 intravenous injections with 20 separate materials given to 69 horses.

(1) Small amounts of air or oxygen injected into the venous circulation were harmless, but small amounts of air injected into the arterial circulation caused severe reactions.

(2) The symptoms produced by the intravenous injection of large amounts of air were, primarily, cardiac and respiratory embarrassment, together with nervous symptoms secondary to a drop in the aortic pressure.

(3) Extremes in rates of injection, temperatures, and amounts of physiological saline solutions, injected had slight clinical effects on the horse.

(4) The normal horse could tolerate large quantities of hypotonic solutions intravenously, but amounts over 4,000 c.c. regularly produced a temporary haemolysis of the blood and haemoglobinuria.

(5) Following the hypertonic sodium chloride injections, an increased peristalsis was noted, together with a definite decline in the coagulation time of the blood.

(6) Sodium citrate solutions injected intravenously caused a definite decline in the coagulation time, and large injections produced symptoms characteristic of acute calcium deprivation.

(7) Lang's solution caused a marked drop in the coagulation time, with an increase in peristalsis, and when it was injected rapidly in large amounts, it produced symptoms characteristic of acute calcium deprivation.

(8) Intravenous injections of 100 to 200 c.c. of a 5 per cent. oxalic acid solution lowered the coagulation time, but produced dangerous toxic effects on the circulatory and excretory systems.

(9) Magnesium sulphate solutions injected intravenously caused a definite decline in the coagulation time, but were poor anaesthetic solutions as the anaesthetic dose was too near the fatal dose.

(10) Chloral hydrate was occasionally toxic for certain old, debilitated horses, especially if the animal struggled during the period of narcosis or anaesthesia.

(11) Chloral solutions produced a definite decline in the coagulation rate and in the body temperature.

(12) Following calcium gluconate injections, there was a definite decline in the coagulation time; large amounts could be injected rapidly in horses without producing marked clinical symptoms.

(13) Formalin (8 to 16 c.c.), in various concentrations with distilled water, was relatively non-toxic and caused a marked rapid decline in the coagulation time and a slight, temporary increase in the red blood cell count.

(14) Moderate or large doses of formalin, injected rapidly, produced clinical symptoms similar to those of histamine or foreign protein shock in the horse.

(15) Gelatin solutions produced a marked rapid drop in the coagulation time after the injection, with no development of unusual symptoms.

(16) Injections of dilute hydrochloric acid did not produce leucocytosis in normal horses and failed to produce other observable circulatory or clinical effects.

(17) Blood transfusions may be given at wide ranges of temperature, from 32° to 138° F., without ill effects, while the injection of overheated blood produced definite symptoms of foreign protein shock.

(18) Tests on 69 normal, experimental horses showed an average, slight to definite, increase in the coagulation time, respiration rate, and pulse rate, and a noticeable decline in the red blood cell count and haemoglobin values when compared with the averages of other workers. These differences might possibly be due to the fact that the horses in general were thin and aged.

(19) The circulatory system of the horse is capable of handling large volumes and strong concentrations of many drugs and materials without permanent injury to the system or to the body.

(20) There is much work yet to be done on the subject of intravenous injections and their effects on the horse.

Acknowledgments.—Recognition and appreciation are given to Drs. E. E. Leasure, E. J. Frick, R. P. Link, and W. W. Thompson for valuable aid, counsel, and laboratory facilities freely offered.

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CLINICAL COMMUNICATION

Nicotine Poisoning in Lambs

H. A. CRAWSHAW, M.R.C.V.S.,
V.O., Bechuanaland Protectorate

Introduction.—The recording by Pybus (1943)[4] and Jones *et alia* (1943)[2] of cases of nicotine poisoning in cattle consequent upon the application of a dressing containing nicotine sulphate to destroy the larvae of the warble fly, and the warning issued by the Ministry of Agriculture in this connection, have prompted the writer to record an accident in which 18 out of a total of 42 lambs dosed with nicotine sulphate and copper sulphate solution died as a result of overdosing. The case under review clearly stresses, if further stress is necessary, the care with which nicotine should be administered, and its danger if given in quantities greater than those recommended.

History.—The original flock consisted of 63 cross-bred blackhead Persian lambs. The native in charge was given a 1-oz. bottle and instructed to dose each with three-quarters of this measure, *i.e.*, ¾ oz. of the worm dose, made up according to the prescription recommended in the Handbook for Farmers in South Africa,[1] which is as follows: 1 oz. powdered copper sulphate, 1 oz. concentrated tobacco sheep dip (containing 40 per cent. nicotine sulphate) and 60 oz. water. Of this solution, two bottles, each containing 26 oz., were made up. It will be seen that ¾ oz. of this solution will contain 2·4 grains of nicotine sulphate and 6 grains copper sulphate. In error, a 2-oz. bottle was used in place of the 1-oz. bottle with the result that the first lambs dosed received a double quantity. After using the first 26 oz. on approximately 17 lambs (that is 1½ oz. each), the native realised that there would be insufficient in the second bottle to dose the remainder of the flock and so the dose was reduced, the next 25 lambs receiving about 1 oz. each or the equivalent of 3·2 grains of nicotine sulphate. The dosing was carried out on August 11th between 9 and 10 a.m., the lambs being kept away from the ewes for about two hours afterwards. The largest lambs were dosed first and it was stated that these were amongst the first to die. The following times of death are only approximate as they were obtained by questioning the natives as to the position of the sun when the deaths occurred.

Number of Deaths	Period in Hours After Dosing
2	3 hours
4	5 ,,
2	8 ,,
1	9 ,,
3	12–20 hours (*i.e.*, during the night of Aug. 11th–12th)
1	30 hours
5	48–60 hours (*i.e.*, during Aug. 13th)
18	

Ante-mortem Symptoms.—Unfortunately no lambs were actually seen by the writer before they died, but the following symptoms were as described by the native in charge. Some of the lambs were seen to be very sick shortly after being dosed. They stood with their heads hanging in an obvious state of discomfort and depression. They would then slowly lie down and remain recumbent for some time, after which they would again get to their feet and move on a little. It was noted that all movements were very slow. No diarrhoea was seen. In one case a lamb that was down was picked up, but died in the boy's arms without any struggling, before he had gone a distance of 50 yards. In the meantime the rest of the flock, including some of the lambs that had been dosed, were grazing normally. Some lambs that showed symptoms of poisoning afterwards recovered.

Post-mortem Findings.—Two *post-mortem* examinations were held, one on a lamb that died after approximately 30 hours and the other on one of the lambs that died on August 13th. The arboration of the mesenteric vessels was most clearly defined in both cases, the blood in them having almost the colour of carboxy-haemoglobin. The rumen, reticulum and omasum were normal, but the oesophageal groove was clearly defined by a severe inflammation of the mucous membrane. The mucous membrane of the abomasum was intensely inflamed, especially in case No. 1, while in the first case, but not in the second, the first 12 inches of the duodenum were stained a brown colour similar to the stain seen on the fingers of heavy smokers. The outer surface of the caecum was coloured a dark blue while the mucous membrane was a similar colour, with a purplish tinge. Unlike the abomasum which contained practically no ingesta, the caecum was filled with a dark, greenish-blue coloured fluid. Some of this was forwarded to the Onderstepoort Laboratory for analysis,

but no nicotine was detected and in the report it was stated that "All the nicotine will be absorbed in the stomach and the initial part of the intestines, so it is to be expected that the caecal contents will, even in cases of nicotine poisoning, contain no nicotine." The liver of the second case showed more advanced fatty degeneration than that of the first, while inflammation in the kidneys was also more apparent.

Weights and Ages of the Lambs.—The average age of the lambs which were dosed but which survived, was three months and three days (youngest two months 21 days, oldest three months 14 days) while the average weight was 37·2 lb. (range from 28 to 46 lb.). The average age of the lambs that died was also three months three days (from two months 20 days to three months 18 days). As the average ages of the two groups were identical it may be assumed that the weights were also approximately the same.

Toxicity of Nicotine.—In his case record Pybus, J.,[4] states that the toxic dose of nicotine sulphate for the cow is said to be 5 to 6 grains, but does not state his authority. An observation made by Mr. F. B. Watermeyer[6] of this Territory, in 1941, would indicate that native cattle can tolerate a much larger dose than this. He stresses that no accurate records were made at the time, and that he is merely quoting from memory, but his observations are of sufficient interest to be recorded. He states, "About ten animals, young bulls and heifers, were dosed with the nicotine-copper sulphate solution of the same strength as prescribed in the Farmers' Handbook, as quoted by you. The ages varied between one year and 18 months, and the weights would have varied between about 300 and 400 lb. (they were in poor condition as they were suffering from worms). To be on the safe side we started by giving 3 oz. to the smaller animals and gradually increased the dose to a maximum of 5 oz. of the mixture in the same dilution as referred to. Those dosed with 3 and 4 oz. showed no visible ill effects, but the 5-oz. dose produced the following symptoms. After about one minute the animals showed nausea and salivation. Their eyes became gradually dull and their heads started to droop. The next symptom, which commenced about three minutes after dosing, was a swaying motion of the body and slight twitching of the muscles. The animals appeared to be losing their balance and staggered in attempts to regain it. This state continued from one to two minutes after they collapsed on to the ground not in a prostrate position but in an ordinary lying position. They were able to keep their heads off the ground but looked extremely depressed. After about ten minutes they recovered sufficiently to stand up, staggered for a short while, and from then on rapidly returned to normal." The animals that showed toxic symptoms received 16 grains of nicotine sulphate. It is stated by Steyn[5] that the fatal dose of nicotine for a full-grown sheep is about 2 to 3 grains, while the fatal dose of nicotine sulphate is from 10 to 15 grains, as the nicotine base is about five times more poisonous than nicotine sulphate. It is pointed out that this dose is a highly fatal one.

Discussion

There was a considerable lapse of time between the first and the last death, as there was before the onset of symptoms in the later cases. In view of the fact that the majority of the lambs that survived must have received about 1 oz. of the solution, which is ¼ oz. more than the recommended dose, it is assumed that the dose of ¾ oz. leaves a fair margin of safety in three-months-old lambs. The toxic dose would appear to lie between 1 and 1½ oz. of solution (3·2 to 4·8 grains of nicotine sulphate or the equivalent of 0·64 to 0·96 of nicotine). The therapeutic dose of the prepared solution for sheep from seven to twelve months old is 1½ ozs.[3] It is interesting to note the delay in the development of symptoms in some cases and the more chronic nature of the *post-mortem* findings in these cases.

Summary

The death of 18 three-months-old lambs, with an average weight of 37·2 lb., as a result of over dosing with a nicotine sulphate, copper sulphate solution is recorded. *Ante-mortem* symptoms, and *post-mortem* findings are described and it is concluded that the toxic dose of nicotine sulphate for lambs of this class lies between 3·2 and 4·8 grains, which is approximately equivalent to from 0·64 to 0·96 grain of nicotine. A report is recorded in which it was found that 16-grain doses of nicotine sulphate (3·2 grains of nicotine) was the dose required to produce toxic symptoms in bulls and heifers of from one year to 18 months of age.

Acknowledgments.—Thanks are due to the Chief Veterinary Officer for permission to publish this case record, to Mr. F. B. Watermeyer for his assistance, and to Dr. B. T. Squires for his criticism and advice.

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ABSTRACTS

[Biochemical Studies of Pregnancy Toxaemia in Sheep. Underwood, E. J., and Robinson, T. J. (1942.) *Austr. vet. J.* **18.** 220-227.]

During 1941 an experiment to study the effect of supplementary feeding of ewes on losses of ewes and lambs and on lamb size and quality was carried out at the Avondale Research Station, Beverley, Western Australia. Half of the 300 ewes used were given a daily supplement of half a pound of grain; all the ewes received oat silage and the animals were run together under normal grazing conditions. In the control group 22 lambs were lost, including nine from five ewes which died from pregnancy toxaemia. In the group receiving the grain supplement only five lambs were lost and there were no cases of pregnancy toxaemia. Blood calcium and ketone bodies were determined at frequent intervals in 40 ewes, including most of the cases of pregnancy toxaemia which occurred.

Serum calcium remained within normal limits in both groups, although there was a very slight fall in the mean value in all the animals towards the end of pregnancy. Ewes which developed pregnancy toxaemia showed no significant fall in serum calcium.

Ketonaemia was first observed seven weeks from lambing, when most of the poorly fed group developed mild to moderate ketonaemia. The only two ewes carrying twin lambs showed very high ketone values and both died from pregnancy toxaemia. Some rise in blood ketones also occurred in the ewes receiving the grain supplement but it was much less pronounced.

Four ewes from each group were subjected to a 48-hour fast. The blood ketones rose in both groups, but in the poorly fed group the rise reached levels similar to those in pregnancy toxaemia and symptoms of this condition did in fact appear but the animals recovered and lambed normally.

The livers of four ewes dying from pregnancy toxaemia showed a very high fat content and almost complete exhaustion of the glycogen reserves. The livers of the foetuses from these ewes were almost free from fat, and glycogen reserves varied from very low levels, comparable to the maternal livers, to considerably higher values which were nevertheless well below the values given in the literature for normal ewes and for new-born lambs.

These results show the practical importance of maintaining good nutritional conditions in ewes during late pregnancy and the ill effects of short periods of starvation.

E. G. W.

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[Titration of Antibody against Influenza Viruses by Allantoic Inoculation of the Developing Chick Embryo. Burnet, F. M., and Beveridge, W. I. B. (1943.) *Aust. J. exp. Biol. med. Sci.* **21.** 71. (11 refs.).]

The principle of the method of titration of antibody described is the "inoculation of the allantoic cavity of fertile eggs with the dilution of virus or serum-virus mixtures being studied and after three days' incubation the testing of allantoic fluid for its power to agglutinate fowl red cells." Nineteen acute and convalescent sera from an epidemic of influenza A were used, the initial amount of antibody and its increase following infection being determined against homologous virus, W.S. virus and swine influenza virus. The results were compared with the corresponding Hirst titrations and mouse lung titrations for the same sera. The titration of sera of 36 comparable persons who did not contract influenza showed an average higher antibody titre than in the case of persons who became infected when estimated by the author's technique, suggesting that it may prove to be a reliable indication of susceptiblity which would be a result of considerable importance. Other advantages of the method are its simplicity and cheapness and its suitability for titrating antibody of influenza B.

A. W. G.

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[*Bacterium friedländeri* in Canine Cystitis. Gray, D. F. (1942.) *Austral. vet. J.* **18.** 236-240.]

A strain of *Bact. friedländeri*, the characters of which are fully described, was isolated on four separate occasions from the abnormal urine of an aged pekingese dog with cystitis. Treatment with hexamine, and later with sulphonamide, led to recovery after a few weeks, when the organism was no longer found in the urine. It is considered that the organism was probably the primary cause of the cystitis.

E. C.

[Isolation of *Bact. friedländeri* from a Case of Septicaemia in a Sucking Pig. Sutherland, A. K. (1944.) *Austr. vet. J.* **18.** 241-243.]

Pure cultures of *Bact. friedländeri* were obtained from the heart blood and lungs of a sucking pig dying after convulsions at two weeks of age. Other piglets on the same premises showed lameness, prostration, and respiratory distress, and some died. At *post-mortem* examination of the piglet from which the organism was recovered, the following lesions were found: congested subcutaneous tissues, congested and oedematous subcutaneous lymph nodes, excess fluid in the peritoneal cavity and pericardial sac, congested and icteric liver, petechiae in the kidneys, congested lungs with some red hepatisation.

The organism isolated caused the death of mice and guinea-pigs after intraperitoneal, and of a rabbit after intravenous, inoculation, but weaner pigs, admittedly older than those affected, could not be infected by intravenous or intratracheal inoculation.

E. C.

REVIEW

[Handbook of Practical Bacteriology. (Sixth Edition.) T. J. Mackie and J. E. McCartney. Pp. 675. E. & S. Livingstone: Edinburgh. Price 17s. 6d.]

In order to cover the advances in bacteriological knowledge which have been made since the last edition of this well-known guide to practical laboratory work was published in 1938 the text has been revised and 89 more pages have been added. The authors' claim that this increase in size was unavoidable seems on the whole to be justified; the book is designed to serve the needs of several classes of workers and contains little if anything that would appear to be redundant to them all. On the whole we feel that a substantial measure of success has been achieved in meeting their varied requirements without undue expansion of the subject matter, but to maintain this will inevitably become more and more difficult as time goes on.

The arrangement of the subject matter into three parts is retained. Part I, which is introductory, deals with the general biology of micro-organisms and immunity in relation to practical bacteriology. Part II is devoted to bacteriological technique including the use of the microscope, methods of cultivating and staining bacteria, the care and use of laboratory animals, immunological and serological methods, certain special techniques as used for testing milk, water, antiseptics and catgut and recommendations for the collection and forwarding of specimens for bacteriological examination. Part III contains much general information regarding pathogenic and commensal micro-organisms of the various bacterial groups together with Rickettsia, fungi, protozoa and viruses, and special reference is made to the methods used for laboratory diagnosis. There is also an Appendix dealing with certain contributions to knowledge which were reported after the proofing of the text had been completed.

We feel that this edition will maintain the reputation of the book as a reliable guide to bacteriological technique and a source of much other information concerning infectious diseases of man and animals. Veterinary students will find it most useful, though they may feel that its value to them is perhaps not quite so comprehensive as it is to those engaged in medicine. It could, however, be made so with no great difficulty but not without some further expansion of the text

SITE FOR LIVER PUNCTURE

Liver puncture with a trocar has been used for the *ante-mortem* diagnosis of equine infectious anaemia, but the usual site of injection (in front of the fifteenth rib) sometimes leads to injury to the intestine and in other cases is difficult because of atrophy or abnormal position of the right lobe of the liver. Wittfogel has found that inserting the trocar just in front of the thirteenth rib, on a line level with the hip joint, is more successful, the trocar thus reaching the liver from the anterior surface after penetrating the diaphragm and a thin section of the lung. It should be mentioned that others do not regard the biopsy method as dependable in the diagnosis of equine infectious anaemia.—*Vet. med.*

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Weekly Wisdom

Surely it is very intelligible to say, and that is what I say here, that Liberal Education, viewed in itself, is simply the cultivation of the intellect as such, and its object is nothing more or less than intellectual excellence.—Cardinal Newman, "Liberal Knowledge its own End."

Questions and Answers

"Questions and Answers" will be published on alternate weeks.

The submission of questions for inclusion in this column will be welcomed. They can relate to any aspect of veterinary work and where publication of the name of the enquirer is not desired, a pseudonym should be supplied, the name and address also being given.

Answers to readers' queries represent exclusively the personal opinions of the writers, and criticism of the replies will be appreciated.

All communications should be addressed to the Editor.

Symptoms of Staphylococcal Mastitis

Q.—*What is the significance of staphylococci in milk? What are the main symptoms of staphylococcal mastitis?*—"*Quarter.*"

A.—In acute forms there is usually blood in the milk and commonly great tenderness of the teats, with no other clinical changes in the udder or cow herself. In more acute cases the quarter itself may be hot, swollen and painful. In some of the cases the quarters may become gangrenous with thick foul-smelling bloody secretion and the cow be seriously ill. Chronic forms commonly show cording of the subcutaneous tissues and enlargement of the supramammary lymph gland, with little or no change in the milk or general health.

"Boils" and "carbuncles" of the udder are commonly due to staphylococci. Staphylococci are common in the milk of apparently normal cows but are usually in small numbers.

Treatment of Warbles in Cattle

Q.—*As derris is now unobtainable, what preparation is recommended for the treatment of warbles in cattle?*—"*Hidebound.*"

A.—This is extremely difficult to answer as we have become so reliant on derris in the past. The only other method which can be recommended with certainty in the control is expression of the ripe warbles. All the alternative drugs which have been tried have proved much less efficient than derris or have had marked objections from the point of view of possible toxic symptoms. One cannot recommend at the moment the use of nicotine wash in view of the fatalities which have so recently occurred. There is reasonable hope that derris may once more be available for next year's warble season; if not, lime and sulphur dip may prove helpful and is certainly safe. Pyrethrum and concentrated salt solution have been recommended.

Interdigital Cyst in the Dog

Q.—*Is there any recent and successful treatment, or method of control, for interdigital cyst in the dog?*—*J. Fulton, M.R.C.V.S.*

A.—In many cases these can be cleared up by the usual surgical operation involving complete destruction of the secreting membrane and by ensuring open drainage. When complete excision is carried out there is generally no recurrence of the lesion in the same location. Yet a great number of cases are highly resistant to treatment and continue to recur. For such cases autogenous and stock vaccines have been tried on innumerable occasions but with only limited success, and the method could never be relied upon.

A method of treatment adopted some years ago at the suggestion of "British Drug Houses" was the oral administration of vitamin A concentrate supplied by that firm for experimental purposes. The preparation had a vitamin A activity of 300,000 I.U. per gramme of oil and was given in doses of 15 to 45 drops daily in the food. There seemed no logical explanation as to why it should be of any value in this condition and the writer commenced its trial entirely without enthusiasm or expectation. But he is glad to record that in quite a number of the worst cases encountered in his practice, the owners have reported complete cures without recurrence.

We know, of course, that some dog owners resort merely to hot fomentations to expedite rupture, and that in a small proportion of cases, healing thereafter takes place; yet in a far larger proportion there is more certainty of cure if a caustic can be applied to the interior of the cyst so as to destroy the secreting membrane lining it.

It is desirable to block the nerve supply to the digits before any kind of surgical interference is proceeded with; and to be careful to neutralise any excess of silver nitrate (which may find its way out of the wound) by applying sod. chloride solution on a wad of cotton wool.

One report speaks of the value of intramuscular injections of "Vivicillin," along with the local application of "Pennotin"; but this needs extended trial and verification.

An Income Tax Query

Q.—*I have a small canine practice for which I use a consulting room (exclusively) and a living room as a waiting room. The maid acts as receptionist and attends to the telephone. The house is assessed at £[illegible] per annum. What would be a reasonable allowance from the profits of the practice?*—"*Q.*"

A.—A general answer to a question of this kind is never satisfactory; the man on the spot, *i.e.*, the local inspector, is the one who can be

deal with it. Our correspondent, therefore, should get in touch with his local Inspector of Taxes who will be only too willing to agree with him the appropriate allowance to be made for part use of his dwelling house for professional purposes.

Definition of "Freshly-calved Cow"

Q.—*How should the term "freshly-calved cow" be defined?*—"Lex."

[The above question is thrown open to our readers for the submission of definitions for publication.]

. . . . . .

Correspondence

Treatment of Aural Haematomata in Cats

Sir,—We have tried the methods advised for the treatment of aural haematomata in cats but results in the majority of cases were disappointing.

The following technique has proved much more satisfactory :—

Under general anaesthesia, incise haematoma boldly, clean off thoroughly, dust with sulphanilamide powder and place the ear in a plaster cast similar to that described by Anderson for use in the treatment of aural haematomata in dogs. Cover with an Elastoplast bandage or loose plaster cast round the head.

Many cases resolve by themselves if left alone.

Yours faithfully,

CHRISTINA G. WITHERINGTON, M.R.C.V.S.

49, Cambridge Street
Aylesbury, Bucks.

ROYAL COLLEGE OF VETERINARY SURGEONS

Membership Examination, July, 1944

List of Successful Candidates

(*Continued from page* 267)

Glasgow

Final Year:

Bannatyne, C. C.	McGuinness, Alex.
Bell, A. K.	Maguire, R. D.
Brownlie, J. F.	Matheson, Arch.
Campbell, Miss D. G.	Matthews, A. C.
Denholm, T. C. (M)	Muir, T. H.
Donald, Miss N. C. H.	Parker, Joseph
Fraser, John	Pollock, J. C.
Gillespie, A. E.	Snowden, J. S.
Hastie, P. S. (M)	Usher, F. J.
Johnston, J. B.	White, G. J.
McFarlane, D. L.	

(M) denotes credit in Medicine.

(*To be concluded*)

NOTES AND NEWS

The Editor will be glad to receive items of professional interest for inclusion in these columns.

Diary of Events

Aug. 2nd.—Meeting of the Western Counties Division, N.V.M.A., at Exeter (Guildhall), 2 p.m.

Aug. 17th.—Meeting of the South-Eastern Division, N.V.M.A., at Maidstone (Royal Star Hotel), 2.30 p.m.

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PERSONAL

Major Frank A. Todd Awarded the Legion of Merit.—Members of the profession who have made the acquaintance of Major Frank A. Todd, Veterinary Corps, U.S. Army, through his welcome presence and contributions at meetings of veterinary societies in this country, will learn with special pleasure that he was awarded the Legion of Merit by General Eisenhower in orders recently published. The citation accompanying the award was as follows:—

"Major Frank A. Todd, Veterinary Corps, United States Army, for exceptionally meritorious conduct in the performance of outstanding services as Veterinary Officer, Iceland Base Command, from September 16th, 1941, to June 1st, 1943. Major Todd was responsible for the establishment and maintenance of proper sanitary standards for the American military personnel in Iceland Base Command. In addition to his assigned duties, Major Todd rendered great assistance to the Government and people of Iceland in the fields of animal husbandry, farm conservation, and research in connection with the diseases of Icelandic domestic animals. Through Major Todd's intelligent and enthusiastic efforts relations between the Icelandic Government and the people of the United States have been greatly enhanced. Entered military service from Iowa."

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Birth.—HENDERSON.—On July 14th, 1944, to Beryl, wife of W. M. Henderson, B.Sc., M.R.C.V.S., Pirbright, Surrey—a son.

. . . . . .

Retirement.—Manchester Corporation Markets Committee reports the retirement of Mr. W. K. Johnstone, M.R.C.V.S., the Chief Veterinary Officer.

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R.C.V.S. OBITUARY

BOYER, Albert Edward, M.B.E., St. Leonards-on-Sea. Graduated London, May 14th, 1895. Died July 12th, 1944.

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GENERAL OBITUARY

MRS. FLORENCE BELL, OF THE ROYAL VETERINARY COLLEGE

A Tribute

Graduates, students, members of the staff and all who have had contact with the Royal Veterinary College during the last two decades will hear with regret of the death of Mrs. Bell. Mrs. Bell came to the College in 1927 to take up the post as nurse in the small-animal department. It was revolutionary to have a woman attendant in the College and it was Sir Frederick Hobday who saw the need and made the innovation. No better choice than Mrs. Bell could have been made, for she soon organised her own section in such a way that there was no doubt that the change was a good one. The nursing of the small animals—canine, feline or fur and feather—seemed to be her one and only thought, and a gratifying result was a great increase in the percentage of recoveries, especially after serious operations. She would fight to get them the comforts which are so essential at such times and woe betide any student or even member of the staff who in any way might unnecessarily interfere with her patients whilst they were in need of rest and quiet.

There is no doubt that Mrs. Bell's work was responsible for a great increase in the number of women employed by veterinary surgeons as small-animal nurses. That her efforts were appreciated by clients and patients was shown by her "fan" mail and the many visitors she had. They would come just to see her and bring flowers for her room and probably some delicacy for her patients. On two occasions she broadcasted on the wireless about her work. She received letters of appreciation from all over the country. She was never still all day long, going from one patient to another giving that caress or soothing word which brought comfort. She would not go home if her patient was in trouble, and many is the night she has spent in the College sitting by a serious case.

Mrs. Bell was a Lancashire woman, her father being a man of letters and the proprietor and editor of a provincial paper. With him she had travelled extensively throughout the world and so she was a most interesting conversationalist. Some 18 months ago she had a heart attack and since then has been far from well. She had to give up her College work and retire to her room. It is sad to think that in her last days she was very lonely and financially embarrassed, but when one visited her it was easy to see that with her indomitable will she was making the best of things and there were no grumblings. She died on Wednesday, July 12th, and was laid to rest on Tuesday, 18th, at Highgate Cemetery. As far as is known she had only one living relative and those present at the funeral were her landlady, with Mr. Douglas, Miss Nisbit, Mr. Frederick Francis, M.R.C.V.S., and Professor McCunn, of the Royal Veterinary College.

J. McC.

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GUY SUTTON MEMORIAL FUND

We are glad to announce the following additional donations to this Fund:—

	£	s.	d.
Mrs. Chester Beatty (a cheque given to Major Sutton the day before his death "to do with as he liked")	52	10	0
Mrs. Guy Sutton	52	10	0
Miss Anne Sutton	2	2	0
Mr. Peter Sutton, M.R.C.V.S.	10	10	0
Mrs. Peter Sutton, M.R.C.V.S.	5	5	0
Mr. Jack Pickup, M.R.C.V.S.	2	2	0
	£124	19	0
Previously reported	1,046	17	6
	£1,171	16	6

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CALL FOR A VETERINARY TRAINING CENTRE IN WALES

In a contribution published in a recent issue of *The Times* Educational Supplement, the Welsh Correspondent of that paper observes that considerable uneasiness is felt in agricultural circles

in the Principality at the recommendations of the recently issued report of the departmental committee on veterinary education, and continues: "For some time Professor Share Jones has been urging that facilities for veterinary education should be provided by the university. Already at Cardiff, Aberystwyth and Bangor the agricultural department have done pioneer work which has not only benefited the farmers but brought them into close contact with the colleges. The proposal to found a veterinary college at Bristol will not meet what are the essential needs of the Welsh farmers, nor will it satisfy the strong desire of the farming community to have within its borders the best scientific and technical advice which it can use and support.

"Before the war and increasingly so during the war years, the success of the attested herds in Wales and the increase in milk production has meant more care of the livestock and its breeding problems. In 1935 about 55 per cent. of the total area of Wales was devoted to crops and improved grass. The main purpose of these crops was the feeding of livestock rather than the production of food for man. In pre-war days it was probably true that 'the essential and almost universal aim of Welsh farming is the production of livestock and of livestock products.' Cattle and sheep and their products produce more than 70 per cent. of the farm income, and the basis of Welsh farming was the livestock industry.

Former Proposals

"The subject of veterinary education is not a new one. In 1913 proposals were adopted for the establishment of a faculty of veterinary science and of animal husbandry, and supported by a large number of local authorities; similar proposals were placed before the Royal Commission on University Education in Wales in 1916. To-day the results of the war years have shown that cattle will still be one of the main products of Welsh farming, and that the increase of the herds and the need for careful breeding will of necessity mean the use of the services of veterinary surgeons. Both the Council of Agriculture for Wales, which recommends the institution of a veterinary school at the University College, Cardiff, and the Welsh Agricultural Organisation Society, have agreed to support the extension of facilities for the veterinary education in the Principality."

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal views of the writer only and must not be taken as expressing the opinion or having received the approval of the N.V.M.A.

Letters to the Editor should reach the Office not later than by the first post on Monday morning for insertion in following Saturday's issue.

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THE N.V.M.A. AND ITS STATE SERVICE MEMBERS

Sir,—My attention has been drawn to a letter by Mr. E. G. Morris under the above heading in your issue of July 15th, 1944, in which certain remarks of mine are quoted that I made at a Council meeting (Supplement, April 29th, 1944, p. 49) when the calfhood vaccination scheme was being discussed. Unfortunately, although the particular excerpt from my remarks is correctly quoted, the deductions made from them are groundless. Mr. Morris deduces from these remarks—particularly from the last sentence which reads "it seemed to him that practitioners were going to gain much from that reorganisation"—the unjustifiable view that "these words clearly show how heavily biased is the Association's policy in favour of the practitioner and against the whole-time man." As my remarks were specifically directed to the proposals before the Council coming from the Ministry and were quite unconnected with any difference between the conditions of employment of part-time and whole-time members of the Ministry's staff, Mr. Morris's inference is an extravagant one and certainly one which I never implied.

It would have been fairer if Mr. Morris had quoted my remarks when in the chair at a previous special meeting of Council called to discuss the scheme. Introducing the discussion, I am quoted as saying (*vide* Supplement, September 11th, 1943, p. 107), "He would like to say, from what was in his own mind and what he knew was in the minds of everybody present, that no matter what might have been said or might be said inadvertently in the enthusiasm of debate, *the Council held it to be essential that the profession should work as a whole in the carrying out of its duties, and that the interests of every section of the profession must be maintained.*"

I respectfully suggest to you, Sir, that the last part of the above quotation, which I have italicised, truly reflects the policy of the "National."

Yours faithfully,

Bentley Hyde, Priory Drive, Stanmore, Middlesex. W. R. Wooldridge.

July 22nd, 1944.

Sir,—In his letter which appeared in *The Veterinary Record* of July 15th, 1944, Mr. E. G. Morris complains of a lack of any real policy of the N.V.M.A. in regard to those of its members who form the State Veterinary Service.

The members of this Service have their own Association, which is a division of the "National," and I should be interested in replies to the following questions:—

Are reports of the Association ever published in the *Record*, the official journal of the parent body?

Are the deliberations of the members, or any resolutions adopted at their meetings, sent to the "National"?

Does the "National" know the real policy of this Association?

Has this Association ever asked the "National" to take any action or to formulate a policy on its behalf?

If the answer to all, or indeed any, of these questions is in the negative, then how can the "National" hope to have a policy in regard to members of a body of which it has no knowledge?

Members of the whole-time staff are welcomed at all meetings of Divisions and Branches of the "National" and usually are members of the local geographical division.

The crux of Mr. Morris's letter is, to my mind, contained in the sentence, "The Ministry's staff is necessarily subject to a certain amount of restriction in its liberty of action and expression." This I understand to mean that the Ministry's staff is debarred from making its voice heard either individually or collectively, and must therefore suffer in silence, while those of us who are under no such restriction are free to speak and fight for what we consider our rightful heritage as a noble profession.

Let Mr. Morris and his colleagues come out into the open and give their fellow-members of the "National" some idea of what they really want done, and I am certain that the members generally will back them to the limit in any reasonable cause they may choose to put forward.

We are all members of one profession, leaving college with identical diplomas, and it is surely time we learned to pull together as a single unit, instead of propagating enmities and jealousies as between groups or even individuals.

Yours faithfully,

Old Bridge House, Haverfordwest, Pem. Charles Watson.

July 22nd, 1944.

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VETERINARY EDUCATION: THE LOVEDAY REPORT

Sir,—The fact that the second report of the Loveday Committee has created so much comment in your correspondence column is a good, healthy sign of criticism; it is a pity, however, that so much of it is destructive, and too frequently revolves around the "one-portal."

The importance of the one-portal is quite clear, but what of the rest of the report? Having served as a big issue in the R.C.V.S. election, the report is now being torn to pieces without considering it either as a *whole*, or as it might benefit the future of our profession. What has been done in the past has been achieved through the foresight of our predecessors, but it appears that we of the present are leaving the future alone if we maintain that the education of the profession is to carry on as before. The requirements of the future veterinarians will be of a different nature if the profession is to keep pace with progress that will surely be demanded by the times. The second Loveday Report presents a big plan embracing status, education and advancement of the veterinary profession, and by accepting it, or even encouraging it, we can show that veterinary science is our concern.

To the anxious members paras. 14 to 16 are sufficiently emphatic to safeguard and even enlarge the duties of the R.C.V.S., as do paras. 25 and 26; also that para. 22 suggests, to advantage, the use of practitioners as clinical examiners; and that the ever pressing, hitherto unsolved difficulty of the menace of unqualified practice will be exposed and, we hope, efficiently dealt with. These are only a few of the items that are in themselves significant; but it is hoped that when the Divisions of the N.V.M.A. have the chance to discuss the report, it will be taken as a *whole*, on constructive lines, and bearing in mind the requirements of future veterinarians; also that a little more gratitude will be shown to the Loveday Committee for the fulfilment of its stupendous task than has been in evidence since the publication of the report.

Yours faithfully,

Whyteleafe, Leatherhead, Surrey. Olga Uvarov.

July 15th, 1944.